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Goddard

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REPLY TO ATTN OF: GP

TO: KSI/Scientific & Technical Information Division
Attn: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,866,210

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : ~

NASA Patent Case No. : GSC-11,582-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

YES ☐ NO ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words "...with respect to an invention of ..."

Bonnie L. Woerner

Bonnie L. Woerner
Enclosure

N73-32120

GSC-11,582-1

United States Patent [19]

Lokerson et al.

[11] **3,866,210**

[45] **Feb. 11, 1975**

[54] **X-Y ALPHANUMERIC CHARACTER GENERATOR FOR OSCILLOSCOPES**

[75] Inventors: **Donald C. Lokerson**, New Carrollton; **Ronald E. Boston**, Baltimore, both of Md.

[73] Assignee: **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration**, Washington, D.C.

[22] Filed: **Sept. 14, 1973**

[21] Appl. No.: **397,477**

[52] **U.S. Cl.** ..... **340/324 AD**, 178/15, 315/18

[51] **Int. Cl.** **G06f 3/14**

[58] **Field of Search** ..... 340/324 A, 324 AD; 178/15

[56] **References Cited**

UNITED STATES PATENTS

3,524,022	8/1970	Schoenthal	178/15
3,786,481	1/1974	Hartman	340/324 AD

Primary Examiner—John W. Caldwell
Assistant Examiner—Marshall M. Curtis
Attorney, Agent, or Firm—Robert F. Kempf; John R. Manning

[57] **ABSTRACT**

A method and apparatus is disclosed by which any general purpose external trigger laboratory oscilloscope can be utilized to display alphanumeric characters. Each character to be displayed is composed of a plurality of segments appearing at various segment positions in various segment rows to define a conventional matrix, various ones of the segments being displayed during each horizontal sweep of the oscilloscope trace. In between character segments to be displayed, or when no display is desired, the trace is effectively blanked by a vertical clamping voltage so as to position the oscilloscope trace in an off-screen position. The "clamping" technique of the invention, i.e., biasing the oscilloscope trace to an off-screen position when no character segment is to be displayed, eliminates the necessity of providing Z-axis modulation to effect blanking.

5 Claims, 3 Drawing Figures

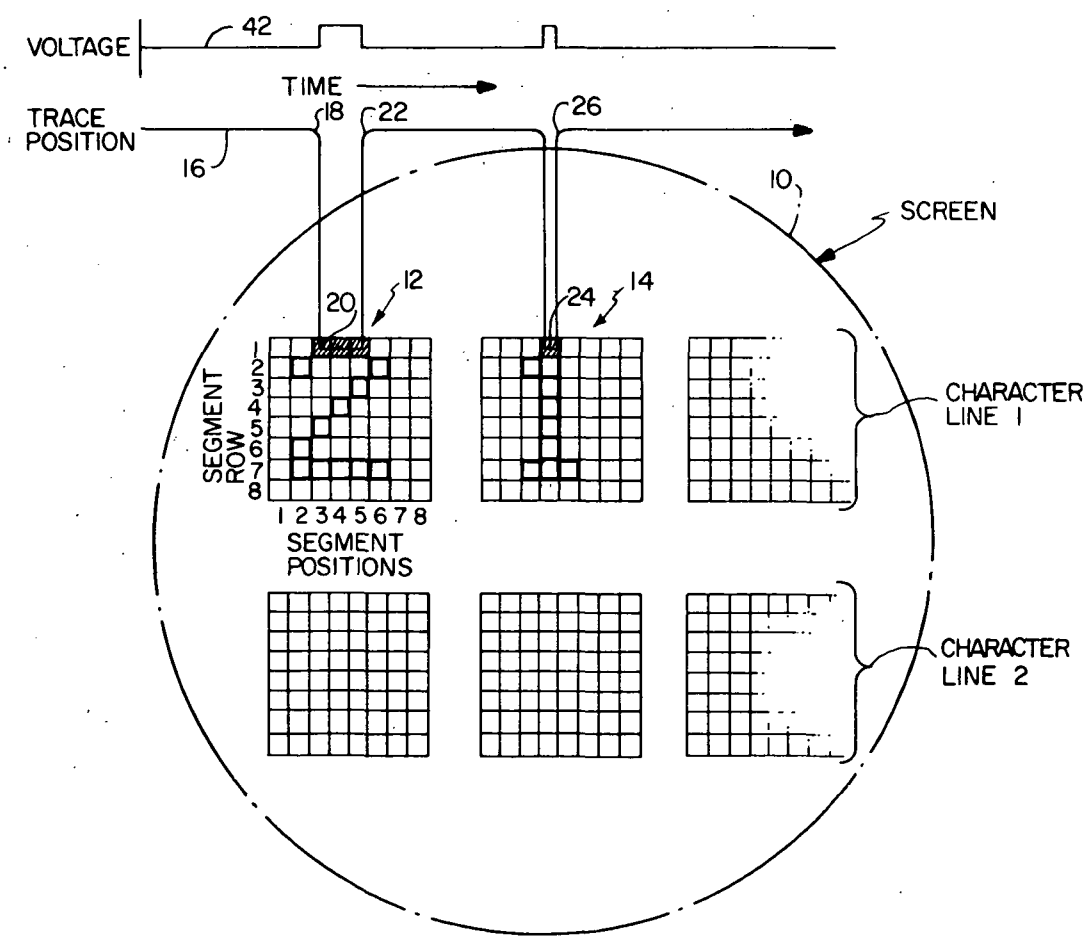
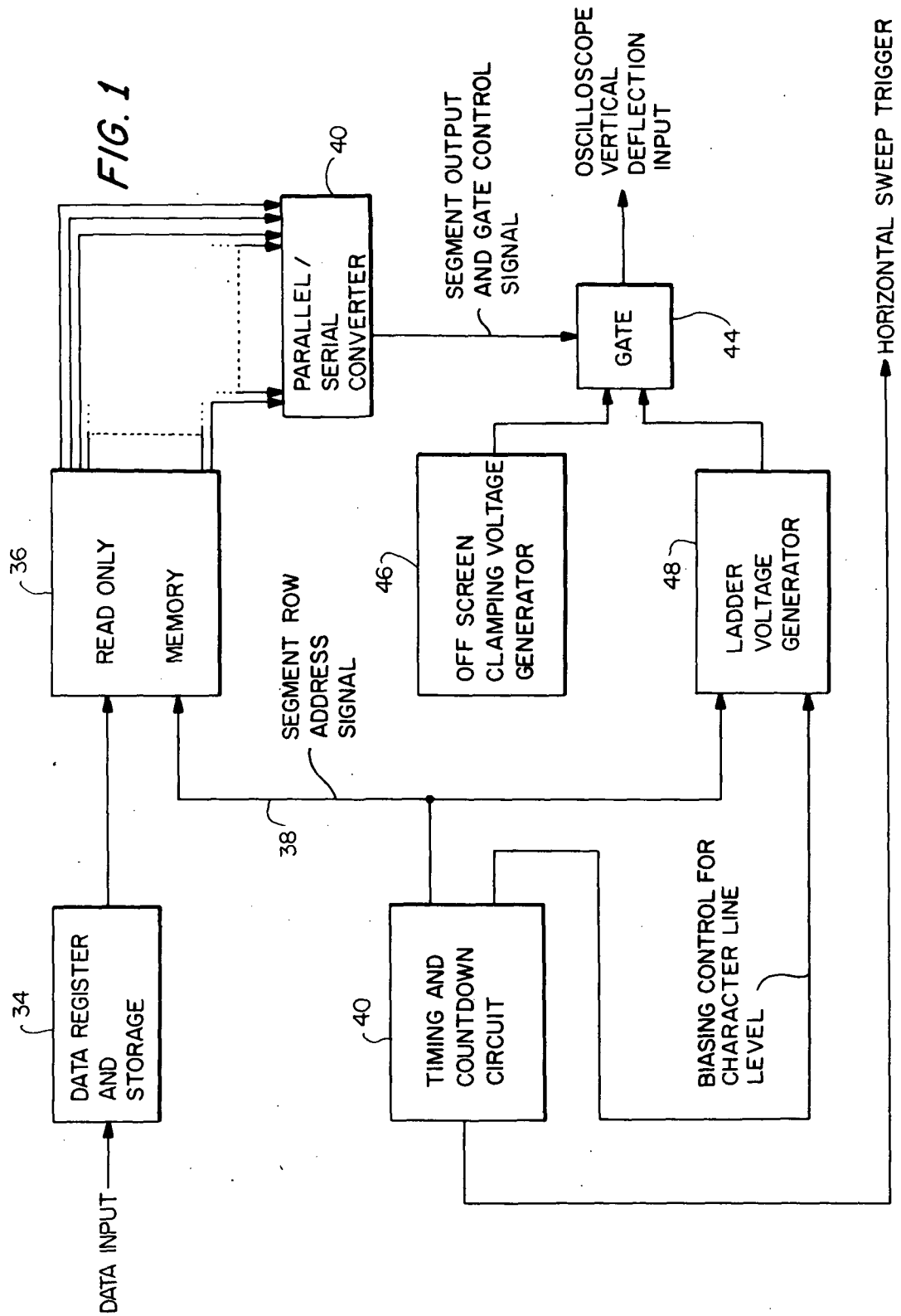


FIG. 1


DATA INPUT
34
DATA REGISTER AND STORAGE
36
READ ONLY MEMORY
38
SEGMENT ROW ADDRESS SIGNAL
40
PARALLEL / SERIAL CONVERTER
SEGMENT OUTPUT AND GATE CONTROL SIGNAL
OSCILLOSCOPE VERTICAL DEFLECTION INPUT
GATE
44
46
OFF SCREEN CLAMPING VOLTAGE GENERATOR
48
LADDER VOLTAGE GENERATOR
40
TIMING AND COUNTDOWN CIRCUIT
BIASING CONTROL FOR CHARACTER LINE LEVEL
HORIZONTAL SWEEP TRIGGER

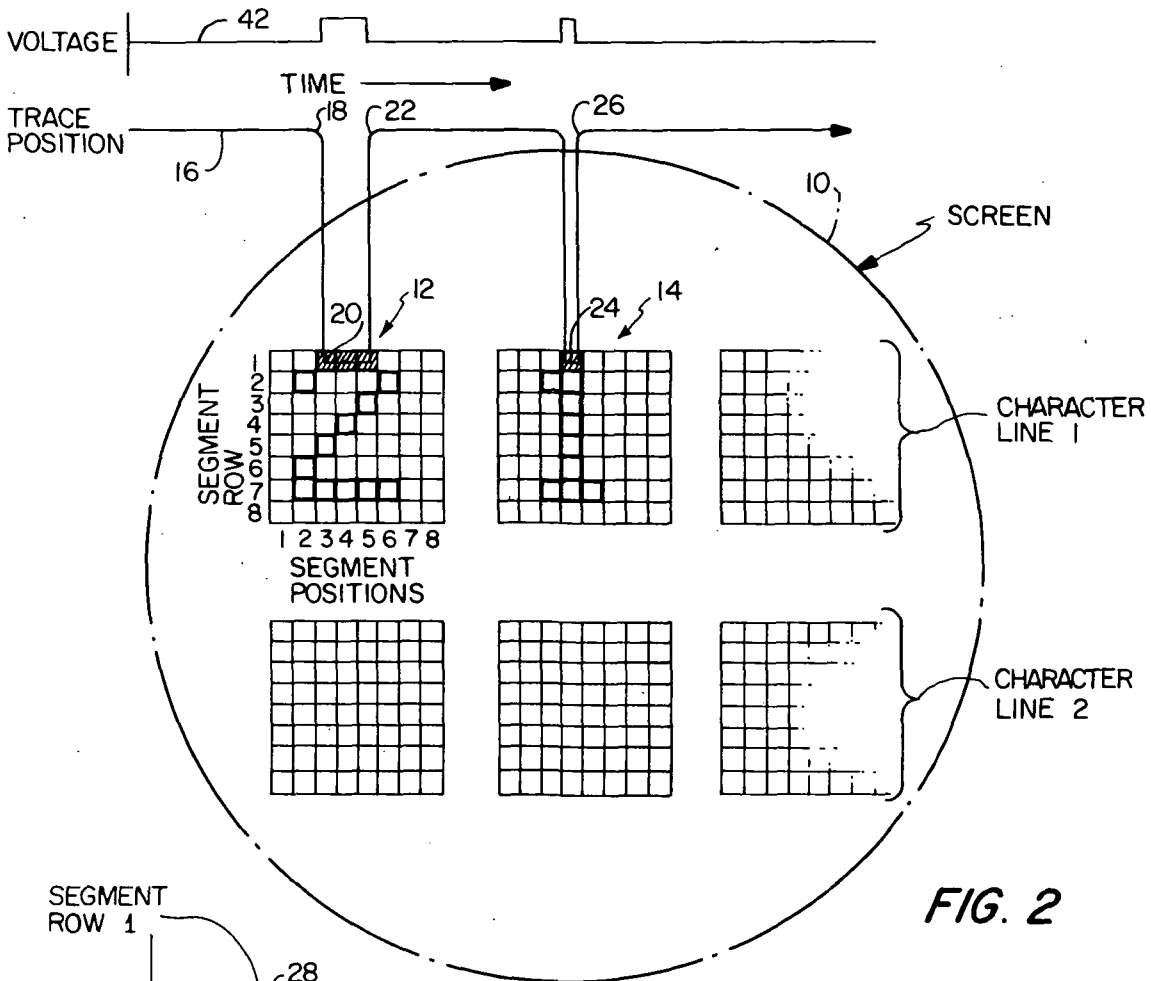

VOLTAGE
42
TIME
TRACE POSITION
16
18
22
26
10
SCREEN
12
14
20
24
SEGMENT ROW
1
2
3
4
5
6
7
8
1 2 3 4 5 6 7 8
SEGMENT POSITIONS
CHARACTER LINE 1
CHARACTER LINE 2

FIG. 2

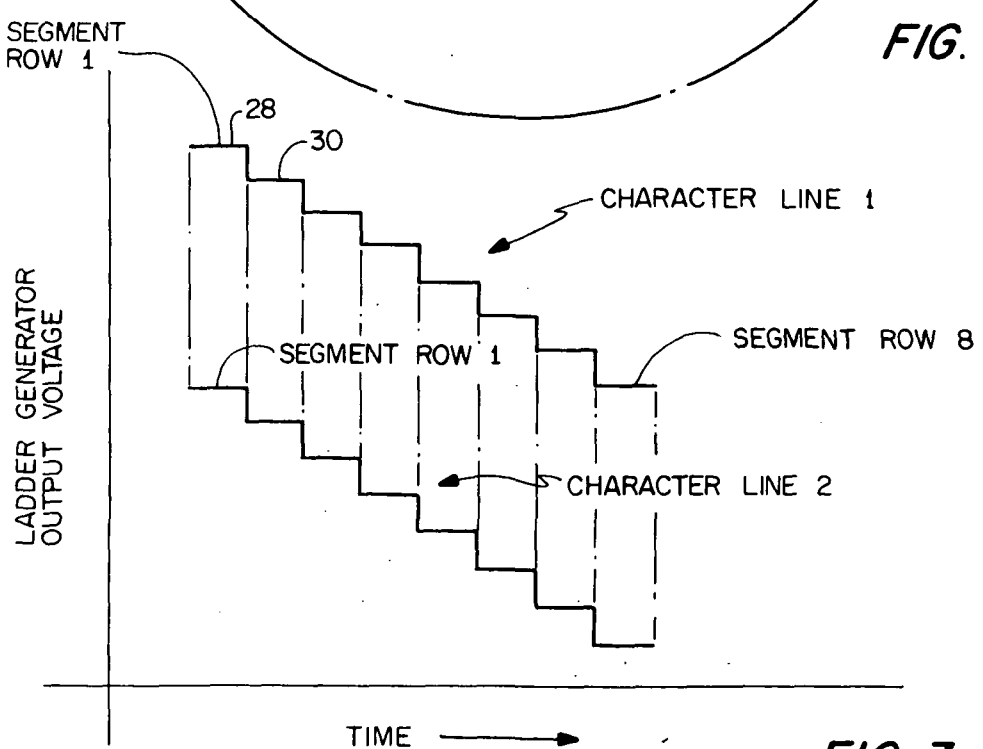

SEGMENT ROW 1
28
30
CHARACTER LINE 1
SEGMENT ROW 1
SEGMENT ROW 8
CHARACTER LINE 2
LADDER GENERATOR OUTPUT VOLTAGE
TIME

FIG. 3

X-Y ALPHANUMERIC CHARACTER GENERATOR FOR OSCILLOSCOPES

ORIGIN OF THE INVENTION

BACKGROUND OF THE INVENTION

This invention generally relates to alphanumeric character display devices and particularly concerns a method and apparatus for effecting a character display on a general purpose oscilloscope

Many techniques are known and in common utilization for displaying data, such as alphanumeric data, generated by various data systems. The most popular methods of displaying such data have been the utilization of printers, and cathode ray tube (CRT) display terminals. Each of these general display devices is quite expensive, utilizes specialized construction, and usually is not very portable.

With particular reference to CRT display apparatus, alphanumeric characters to be generated are typically displayed on the screen in a plurality of character segments disposed in some matrix pattern. During each horizontal sweep of the electron beam of the CRT display tube, a different row of character segments are generated, the complete raster thereby generating a plurality of character lines on the screen. During the sweep of the electron beam, the CRT screen must be blanked when no character segment is to be displayed, the intensity of the beam being markedly increased at display locations of character segments so as to provide the necessary contrast. Thus, with the typical CRT display device, Z-axis modulation of the beam of trace must be effected. As can be appreciated by those skilled in the art, the requirement for Z-axis modulation markedly increases the sophistication and complexity of the display terminal. Typical of such CRT display devices is the character display apparatus to be found in U.S. Pat. No. 3,659,283.

Thus, with the current state of technology, if a CRT device is desired to be utilized to effect alphanumeric character display, sophisticated and specialized design of equipment is necessary.

BRIEF SUMMARY OF THE INVENTION

The instant invention has as its primary objective the provision of a technique and apparatus by which any general purpose laboratory oscilloscope having external triggering can be utilized as an alphanumeric character display unit, thus eliminating the current necessity of utilizing sophisticated, specialized, and expensive apparatus where CRT displays are desired.

This significant objective as well as others which will become apparent as the description proceeds are implemented by the instant inventive process which can simply be described as a technique wherein the necessity of Z-axis modulation of a CRT trace is eliminated, the "blanking " function of Z-modulation being achieved by clamping the CRT trace in an off-screen position where it cannot be seen. Thus, a general purpose oscilloscope may be utilized as the CRT display apparatus, there no longer being any need for Z-modulation of the scope trace.

More specifically, each character to be displayed is composed of a plurality of segments appearing at various segment positions in various segment rows to define a conventional matrix. A signal is initially generated to the horizontal sweep trigger input of the general purpose oscilloscope to initiate a horizontal sweep of the oscilloscope trace. If no character segment is to be displayed, a vertical deflection signal is held at a clamping voltage so as to position the oscilloscope trace in an off-screen position. When a character segment is to be displayed during the horizontal trace, a vertical deflection pulse is generated in the desired position, the voltage value of the pulse being such as to position the top of the corresponding oscilloscope trace pulse thereby produced from the off-screen or "clamped" position to a level which is visible on the oscilloscope screen. Only the flat top of each oscilloscope trace pulse produced is visible thereby giving the appearance of a dash which constitutes a character segment. During each successive horizontal sweep of the oscilloscope trace, the value of the vertical deflection pulses is altered to position the top of each oscilloscope trace pulse generated during a respective horizontal sweep as a different on-screen level corresponding to the desired level of a respective row of character segments.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood, and further features and advantages thereof will become apparent, from the following detailed description of a preferred inventive embodiment, such description making reference to the appended sheets of drawings, wherein:

FIG. 1 is a schematic electrical block diagram of the apparatus utilized to practice the technique of the instant invention whereby a general purpose oscilloscope is converted into a CRT alphanumeric character display device;

FIG. 2 is a diagrammatic view of the typical oscilloscope screen illustrating the manner in which alphanumeric characters are displayed thereon in accordance with the teachings of the instant invention; and

FIG. 3 is a graphical illustration representative of various voltage levels generated and applied to the vertical deflection terminal of an oscilloscope during operation thereof as an alphanumeric character generator.

DETAILED DESCRIPTION OF A PREFERRED INVENTIVE EMBODIMENT

With reference now to FIG. 1 of the application drawings, a schematic block diagram of the character generating apparatus of the instant invention is disclosed, this apparatus to be coupled to the vertical deflection input of any general purpose laboratory oscilloscope having an external sweep trigger. Broadly speaking, the external horizontal sweep trigger of the oscilloscope is pulsed so as to initiate a horizontal sweep of the scope trace. If no character segment is to be displayed, the vertical deflection input signal is held at a clamping voltage to bias the oscilloscope trace in an off-screen position. When a character segment is to be displayed, a vertical deflection pulse is generated in the desired position on the oscilloscope screen. Only the flat top of the oscilloscope trace pulse is seen, thereby giving the appearance of a short dash which constitutes a character segment. A read-only-memory is utilized to determine whether or not a segment is to be displayed during a horizontal sweep. During subse-

quent horizontal sweeps of the oscilloscope trace, the level of each oscilloscope trace pulse is altered, the vertical position of the trace pulse and thus the character segment being determined by the state of a ladder network.

With reference now to FIG. 2 of the application drawings, a better understanding can be obtained of the technique whereby alphanumeric characters can be displayed on the screen of a general purpose oscilloscope. In FIG. 2, the screen of the oscilloscope is designated by reference numeral **10**. A plurality of characters such as the character designated by reference numeral **12** are to be displayed on the screen in a desired format. For example, and for purposes of this discussion, let it be assumed that eight characters, such as character **12**, are to be displayed in a given character line, and that a plurality of character lines, such as character lines **1** and **2**, are desired to be displayed on the screen **10**.

Each character, such as character **12**, is composed of a plurality of individual segments in a matrix, such as the 8 × 8 matrix illustrated. These character segments can therefore be found in eight different segment positions in a segment row, there being eight different segment rows, each segment row being vertically spaced from one another. As is shown, a horizontal spacing is effected between each character of a character line, and a vertical spacing is effected between each different character line.

To display a complete numeral, such as number two as indicated by reference numeral **12**, character segments are necessary at segment positions **3**, **4** and **5** in segment row **1**, in segment positions **2**, and **6** in segment row **2**, and so forth as can be noted from FIG. **2** of the drawings. With respect to the display of a complete number one as is indicated by reference numeral **14**, a character segment would be desired at segment position **4** in segment row **1**, at segment positions **3** and **4** in segment row **2**, and so forth. As those skilled in the art can appreciate, any alphanumeric character can be constructed of a plurality of segments in a matrix-like manner in similar fashion.

So as to display the desired segments of each complete numeral as is shown, all segments of segment row **1** of each character in a character line would initially be displayed during the first horizontal sweep of the oscilloscope trace. During the next horizontal sweep of the oscilloscope trace, all required segments in segment row **2** of each character of character line **1** would be displayed, and so forth. The oscilloscope screen **10**, of course, must be "blanked" at those segment positions along each horizontal sweep at which no character segment is to be displayed. To effect this "blanking" without requiring the utilization of Z-axis or intensity modulation of the oscilloscope beam, the following novel technique is used.

Initially, a horizontal sweep trigger signal is generated and applied to the external trigger of the oscilloscope to commence the horizontal sweep. The oscilloscope trace, however, is biased or "clamped" to an off-screen vertical position such as is indicated by reference numeral **16**. As the horizontal sweep commences, and the oscilloscope beam is at an off-screen position immediately above a character segment to be displayed, such as position **18**, a vertical deflection pulse is generated having a voltage value sufficient to move the oscilloscope trace from the off-screen position to a new position at the level of segment row **1**. The pulse so produced is a square-wave and, thus, the top **20** of each corresponding oscilloscope trace pulse becomes visible as a short dash at segment position **3** of segment row **1**. The vertical deflection pulse produced would have a duration long enough so that the character segments at positions **3**, **4**, and **5** of segment row **1** of the character designated by reference numeral **12** would be displayed. At that time, the vertical deflection pulse would extinguish, causing the oscilloscope trace to return to its biased or "clamped" off-screen position as represented by reference numeral **22** at this point in time. Since the vertical deflection voltage pulse applied has a sharp rise-time and cut-off, only the horizontal portion or flat top of the corresponding oscilloscope trace pulse would be visible to the viewer of screen **10**.

As the first horizontal sweep progresses, the electron beam or trace arrives at a position aligned with segment position **4** of segment row **1** of the character indicated by reference numeral **14**. A further vertical deflection pulse is generated causing the oscilloscope trace to be deflected to the level of segment row **1** for a duration long enough to display the flat top of the trace pulse **24** so as to display a character segment at this position. The vertical deflection voltage pulse thereafter would cease, and the oscilloscope trace would return to its off-screen position as indicated by reference numeral **26**. All segments in segment row **1** of the various characters found in character line **1** would be displayed in similar and successive fashion.

Display of the desired character segments in segment row **2** of character line **1** is effected by the next horizontal sweep of the oscilloscope trace. Thus, the external trigger of the oscilloscope would be pulsed once again to commence a further sweep of the electron beam. In this instance, for example, a vertical deflection pulse would be generated when the beam was aligned above segment positions **2** and **6** of segment row **2** of the character designated by the reference numeral **12**, thus effecting a display of these particular character segments. The value of the vertical deflection pulse applied in this instance, however, is of necessity different than the value of the vertical deflection pulse applied when a display of segments was desired or effected in segment row **1**. Specifically, the electron beam or trace now must be deflected to a new or lower position during this horizontal sweep, so as to position the top of the corresponding oscilloscope trace at the level of the segment row **2**. During each successive sweep of the oscilloscope trace, the values of the vertical deflection pulses are successively varied in a stepwise or ladder-like arrangement as indicated in FIG. **3** of the drawings so that, upon completion of eight sweeps of the electron beam, an entire or complete character would have been displayed at each character position of character line **1**. Thus, for example, to display character segments appearing in segment row **1** of character line **1**, the voltage of the vertical deflection pulse would be at a level indicated by reference numeral **28** of FIG. **3**. During the next sweep of the electron beam, wherein a display of character segments in segment row **2** is desired, the value of the voltage of the vertical deflection signal would be altered to be at a new value indicated by reference numeral **30** of FIG. **3**, and so forth.

After all alphanumeric characters in character line **1** have been displayed in the aforementioned fashion, al-

phanumeric characters in character line 2 would thereafter be displayed in similar fashion with all character segments in segment row 1 first being displayed, then character segments in segment row 2 thereafter being displayed, and so on until all characters in character line 2 have completely been displayed. Of course, the position of the top of the oscilloscope trace, such as the top of the pulse represented by reference numeral 20 and 24, would be significantly lowered on the screen 10 of the oscilloscope to be at a level corresponding with the level of the particular segment row and character line being displayed. As explained above, this is accomplished by varying the level of voltage of the vertical deflection pulse applied. With reference again to FIG. 3 of the application drawings, the voltage level of the vertical deflection pulse has a ladder or staircase wave form, with each step being representative of the level of a different segment row within a character line. When a new character line is desired at a different position on the screen, such as character line 2, the entire staircase or ladder wave form is altered in value such as is shown with respect to character line 2 in FIG. 3. For each new character line desired on the screen 10 of the oscilloscope, an adjustment of the value of the overall staircase wave form would be effected so as to adjust the level of the flat top of the oscilloscope trace pulses so generated from the off-screen or "clamped" position.

With reference now to FIG. 1 of the application drawings, suitable apparatus for carrying out the above-described operation is illustrated. The specific form of such apparatus is exemplary only.

Data input representative of desired alphanumeric characters to be displayed on the general purpose oscilloscope is initially provided as a plurality of binary bits in accordance with virtually any desired code. For example, and assuming a display format of two lines of characters, eight characters per line, and a hexadecimal code for each character, the data input would constitute 64 bits of data in the form of 16 hexadecimal characters. This input is presented to a data register and storage means 34 or a trunk line wherein all 64 bits of input data in the form of the 16 hexadecimal characters are stored. The data register and storage means 34 is of typical and conventional construction and could consist of four 16-bit shift registers, for example. Data is read out from storage means 34 four bits at a time in this example, and thereafter fed to a read-only-memory 36. The use of the data register and storage means 34 permits asynchronous operation of the character generator with the source of data input.

Character conversion is effected by the read-only-memory 36 in typical fashion. In accordance with the input code, a specific and predetermined alphanumeric character is selected and a parallel output is provided from the memory 36 representative of the existence or non-existence of a character segment of the selected character at a given segment position in a given horizontal segment row. Thus, each character is stored in the read-only-memory 36 as 64 bits in the form of eight 8-bit words. A timing input or segment row address signal provided to memory 36 on trunk line 38 comprising a plurality of conductors from the timing and count-down circuitry 40 to be discussed hereinbelow, determines which word is to be read out from the character memory 36. Specifically, a logical one in the output from memory 36 indicates that a character segment is to be present at a particular point in the matrix, while a logical zero output indicates the absence of a segment at the given position. As mentioned, the segment row address signal on trunk 38 assures that a pattern of segments will be generated which will produce a recognizable character with the right segments being displayed at the right time.

The parallel outputs of memory 36 are converted to a serial stream of binary ones and zeros by a parallel-to-serial convertor 42, whose output constitutes the segment output and gate control signal as shown.

With particular reference, again, to FIG. 2 of the application drawings, the output from the parallel-to-serial convertor 40 is indicated by line 42. Again assuming that the first segment row of the first character line is to be displayed, the read-only-memory 36, having inputted therein the data information representative of the specific alphanumeric characters desired, would effect a logical one output at a time when the horizontal trace of the oscilloscope was aligned with segment positions 3, 4 and 5 of the character designated by reference numeral 12, and segment position 4 of the character designated by reference numeral 14, thus providing a gate control signal as shown at 42 for the first horizontal sweep. The output from the read-only-memory 36 for all other segment rows and character lines will be produced in a similar fashion.

The gate control signal provided by the read-only-memory 36 is utilized to control a gate 44 which has as its function to apply either one of the two inputs thereto to the vertical deflection input of the oscilloscope. A generating means 46 is connected to one of the inputs of gate 44, generating means 46 serving to generate a vertical clamping voltage of a value to vertically bias the oscilloscope trace in an off-screen position. The second input to gate 44 is coupled to generating means 48 which serves to generate a vertical deflection voltage of a value to vertically position the oscilloscope trace at a level on the oscilloscope screen corresponding to a desired level of a horizontal row of segments of characters to be generated. Generating means 48 is a ladder voltage generator of conventional construction which provides at its output the staircase voltage wave forms indicated in FIG. 3 of the application drawings. A biasing control input to the ladder voltage generator 48 determines the overall level or value of the staircase wave form generated, for example, whether such wave form would be representative of character line 1, character line 2, etc., as shown in FIG. 3. The particular "step" of the staircase voltage being generated by ladder voltage generator 48 is correlated with the particular character segment being displayed by a timing and count-down circuit 40 which further effects periodic and synchronous generation of a horizontal sweep trigger pulse. Timing and count-down circuit 40 again is of a conventional construction constituting an oscillator coupled to a plurality of counters.

When the segment output and gate control signal from read-only-memory 36 is a logical one, the voltage output from ladder voltage generator 48 is applied to the vertical deflection input of the oscilloscope. On the other hand, when the output from the memory 36 is a logical zero, the off-screen clamping voltage from generator 46 is applied to the vertical deflection input of the oscilloscope.

With reference now to FIGS. 1 and 2 of the application drawings, the operation of the typical circuitry in

FIG. 1 will be described with respect to the first horizontal sweep of the oscilloscope trace so as to effect display of character segments in segment row 1, character line 1 of characters represented by reference numerals 12 and 14. Read-only-memory 36, having been provided a data input designating all desired characters to be displayed on the oscilloscope screen, would provide an output representative of the existence or non-existence of a character segment of each different segment position along segment row 1, this output being a binary one or zero as shown by chart 42 of FIG. 2. Prior to generation of the memory output, timing and count-down circuit 40 would have initiated a horizontal sweep of the trace and would have biased the ladder voltage generator 48 to generate a staircase voltage as shown in the upper portion of FIG. 3, and specifically at a level designated by reference numeral 28.

The output from the memory 36 initially would be at a logical zero thus controlling gate 44 to apply the off-screen clamping voltage from generator 46 to the oscilloscope vertical deflection input. Thus, the oscilloscope trace would be an off-screen level indicated by numeral 16 in FIG. 2.

When the oscilloscope trace was aligned with a position of segment 3, of segment row 1, as designated by numeral 18, the output from memory 36 would change to a logical one thus controlling gate 44 to switch the output from ladder voltage generator 48 to the vertical deflection input of the oscilloscope. The output of ladder voltage generator 48 at this point in time would be at a level indicated by reference numeral 28 of FIG. 3, sufficient to cause the top of the oscilloscope trace pulse to be positioned at a level corresponding to the level of segment row 1 of character line 1. For the next three segment positions, the output from the read-only-memory 36 would remain a logical one. Thus, three character segments at levels indicated by reference numeral 20 would be displayed on the oscilloscope screen. Thereafter, the output from memory 36 would once again become zero, switching the clamping voltage 46 to the vertical deflection input of the oscilloscope and returning the oscilloscope trace to the off-screen or clamped position, as at reference numeral 22 of FIG. 2. The output from the read-only memory 36 will remain at a logical zero until the oscilloscope trace is aligned with segment position 4 of the second character represented by reference numeral 14 of character line 1. At this point, the output from memory 36 will change to a logical one causing a voltage at level 28 of FIG. 3 from the ladder voltage generator 48 to be applied to the vertical deflection input of the oscilloscope, thus positioning the top of the oscilloscope trace at level 24 of FIG. 2 so as to display a character segment. The output from the memory 36 would once again revert to zero, causing the clamping voltage from generator 46 to be applied to the vertical deflection input of the oscilloscope and causing the oscilloscope trace to return to the off-screen position designated be reference numeral 26 in FIG. 2.

During the next sweep of the oscilloscope beam initiated by the timing and count-down circuit 40, the oscilloscope trace will again be moved from an off-screen position to an on-screen position with the flat top of each oscilloscope trace pulse now being at a level corresponding to segment row 2 of character line 1, ladder voltage generator 48 now generating a voltage at a level corresponding to the second step 30 of the staircase wave form shown in FIG. 3.

In this fashion, all character segments of all characters in each character line are displayed on the screen 10 of the oscilloscope, it being appreciated that the persistence of the screen 10 maintains the character segments visible until a further raster is generated. It should further be appreciated by those skilled in the art that various other display formats can be utilized if desired, all within the general teachings of the invention which, through the utilization of off-screen clamping of the oscilloscope trace, effects a selective "blanking" of the trace without Z-axis modulation.

From the foregoing detailed description, it should be apparent that the objectives set forth at the outset of this specification have been successfully achieved. Moreover, while there has been shown and described a present preferred embodiment of the invention, it is to be distinctly understood by those skilled in the art that the invention is not limited thereto, but may otherwise be variously embodied and practiced within the scope of the following claims. Accordingly,

What is claimed is:

1. An alphanumeric character generator for generating characters on the screen of a general purpose oscilloscope of the type having an external horizontal sweep trigger input and a vertical deflection input, said character generator comprising: means for generating a vertical clamping voltage of a value to vertically bias the oscilloscope trace in an off-screen position; means for generating a vertical deflection voltage of a value to vertically position the oscilloscope trace at a level on-screen corresponding to a desired level of a horizontal row of segments of characters to be generated; means for sequentially generating a plurality of control signals, each representative of a different character segment of a plurality of segments to be successively displayed in predetermined segment positions along a horizontal row on the oscilloscope screen during a horizontal sweep of the oscilloscope trace; and gate means coupled to each said generating means responsive to each control signal for selectively and successively presenting to the vertical deflection input of the oscilloscope either said vertical clamping voltage or said vertical deflection voltage; whereby character segments are displayed by successively moving the oscilloscope trace between the off-screen vertical position and the on-screen vertical position during a horizontal sweep of the oscilloscope trace.

2. a character generator as defined in claim 1, wherein each fully completed character to be displayed is composed of a matrix of a plurality of segments disposed in selected segment positions along a plurality of different horizontal rows, each horizontal row being vertically displaced from one another on the oscilloscope screen; and wherein said means for generating said vertical deflection voltage generates a deflection voltage having a staircase wave form, each step of the wave form being of a value corresponding to the level of a respective different horizontal segment row during successive horizontal sweeps of the oscilloscope trace; said character generator further comprising trigger means for periodically generating a horizontal sweep trigger signal; and timing means for effecting synchronous operation of said vertical deflection voltage generating means, said trigger means, and said control signal generating means.

3. a character generator as defined in claim 2, wherein said plurality of horizontal rows in which a fully completed character is displayed comprises a character line, and wherein a plurality of character lines are displayed, each character line being vertically displaced from one another on the oscilloscope screen; adjusting means being provided for said vertical deflection voltage generator to shift the values of the staircase wave form generated thereby such that the wave form is of a value to position the oscilloscope trace at a level on-screen corresponding to the level of each respective character line.

4. A method of generating alphanumeric character segments on the screen of a general purpose oscilloscope of the type having an external horizontal sweep trigger input and a vertical deflection input, said method comprising the steps of: biasing the oscilloscope trace to an off-screen vertical position; generating a horizontal sweep trigger signal; and sequentially generating a train of spaced square wave vertical deflection pulses during each horizontal sweep of the oscilloscope trace, each pulse and the spacing therebetween being representative of the existence and position of a different character segment to be displayed, each said deflection pulse being of a value so as to position the top of each corresponding oscilloscope trace pulse from an off-screen position to a lvel which is visible on the oscilloscope screen, only the top of each oscilloscope trace pulse thereby being visible, thus giving the appearance of a dash.

5. The method defined in claim 4, wherein during each successive horizontal sweep of the oscilloscope trace, the value of the vertical deflection pulses is altered to position the top of each oscilloscope trace pulse generated during a respective horizontal sweep at a different on-screen level corresponding to the desired level of a respective row of character segments, a plurality of character segment rows defining a complete character display.

* * * * *